National Aeronautics and Space Administration

NASAfacts

RATS – Research And Technology Studies

NASA is actively planning to expand the horizons of human space exploration. With the Space Launch System and the Orion Multi-Purpose Crew Vehicle, humans will soon have the ability to travel beyond low Earth orbit. NASA's goal is to send humans to explore deep space beyond the International Space Station, and the work necessary to accomplish this has already begun.

NASA's Research and Technology Studies (RATS) team evaluates technology, human-robotic systems and extravehicular equipment for use in future human space exploration missions. These evaluations are conducted in simulated space environments, or analog tests. Prototype hardware and systems provide a knowledge base that helps scientists and engineers design, build and operate better equipment and establish requirements for human spaceflight operations and procedures. NASA engineers, scientists and technicians from across the country have gathered annually with representatives from industry and academia to perform analog tests for future missions to near-Earth asteroids (NEA), the moon and Mars. The mission simulations help the RATS team determine the system requirements necessary to explore distant locations while developing the technical skills required of the next generation of explorers.

RATS is one of a suite of NASA's analog tests. Each analog helps NASA test and validate future spaceflight mission concepts, conduct technology demonstrations and understand system-wide technical and operational challenges. For more information on RATS and other NASA analog missions, visit: http://www.nasa.gov/exploration/analogs.

RATS 2012

RATS 2012 marks the first time the simulation has moved out of the desert. To simulate the microgravity environment that future explorers will experience at an asteroid, the RATS team is taking advantage of tools available at the Space Vehicle Mockup Facility, or SVMF, at NASA's Johnson Space Center in Houston.

For this year's mission, a crew of four will use NASA's prototype multi-mission Space Exploration Vehicle (SEV), the Active Response Gravity Offload System (ARGOS), the Virtual Reality (VR) Laboratory and the Analog Mission Control Center to gather data. This data may help NASA explore an asteroid in the future. All communications and data transmissions with the Analog Mission Control Center will be conducted over a 50-second time delay (each way), which represents the expected delay during a real mission to a NEA.

ELEMENTS

SEV

The latest generation of NASA's crewed rover – the multi-mission Space Exploration Vehicle – doesn't have wheels. While exploring an asteroid, wheels will not be needed because there is not enough gravity to land a vehicle on the surface. Instead, a roomier version of the previous rover's cabin (upgraded according to input provided in part through previous RATS tests) will be used. In space, it would have thrusters that would allow it to fly around the surface of an asteroid.

The next generation of the SEV will be built as a test flight vehicle capable of being flown in space. Before NASA is ready to progress to that point, however, the new cabin design needs to be checked and evaluated for habitability. Over the course of the 10-day RATS 2012 test, two crews each consisting of a scientist and flight controller will take turns eating, sleeping, exercising and working inside the SEV for three days and two nights, as though they were on a mission to an asteroid. They will assess the system displays, controls and views, as well as its general comfort for living.

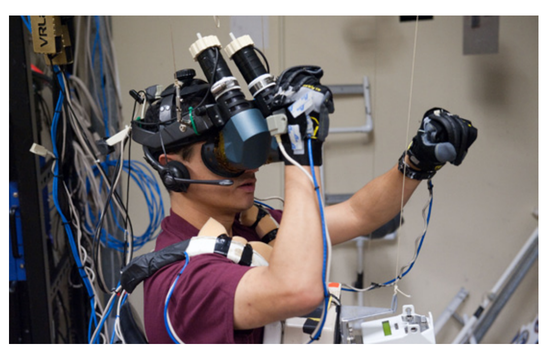
NEA Simulation

There are many advantages to performing this year's tests in the SVMF, but one disadvantage is that the view outside the SEV's windows will not be a convincing substitute for an asteroid. NASA's modeling and simulation team solved that problem by developing a physics-based asteroid simulation that contours around the front windows of the SEV. The crew's view is a realistic representation of the asteroid they are attempting to explore.

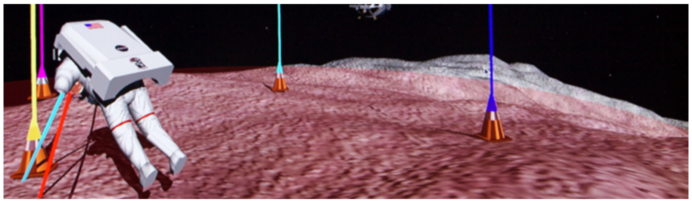
Using scientifically accurate asteroid models, NASA will gain a better understanding of how to effectively conduct operations at an asteroid and how to efficiently use propellant and other finite resources for asteroid exploration. Additionally, the crew will be able to provide feedback on the SEV's window configuration and camera views, as well as its various control modes, attitudes and capabilities.

VR Lab

The video wall is useful only when the crew is inside the SEV. Once they step out of the vehicle for a spacewalk, there is no hiding that they are in the SMVF. Luckily, NASA has plenty of experience in simulating spacewalks, and the VR Lab that helps the agency do so is in the same building as the SMVF. The VR Lab has long been used to simulate microgravity spacewalks for space shuttle and International Space Station crews. By donning a VR helmet and gloves, crew members will see the same asteroid landscape visible through the SEV's windows. The gloves track their hand movements through the simulation, enabling them to reach out and grab virtual rock samples, just as they would on a real spacewalk.



Inside the lab, crew members will simulate two different modes of spacewalks. The first is free flying, which uses a virtual jetpack modeled after the Manned Maneuvering Unit and Simplified Aid For EVA Rescue pack used by the shuttle and station programs. The other type is where the astronaut is anchored. For this mode, the astronaut works from a virtual foot restraint attached to the front of the SEV.



ARGOS

Where the VR lab leaves off, the Active Response Gravity Offload System picks up. ARGOS is a highly specialized crane from which crew members can be suspended while their weight is offset to simulate different amounts of gravity. It can be used to make spacewalkers feel as though they weigh 1/6 of their weight, as they would on the moon, or 1/3, as on Mars. It also can simulate the weightless effect of an asteroid with no gravity, which is similar to the experience on the International Space Station.

For RATS 2012, ARGOS will be used in two ways: as part of the integrated asteroid mission, along with the SEV, VR lab and other elements, and as a stand-alone test to assess asteroid sample collection and spacewalking tools, as well as science operations and procedures. Some of the same tools and techniques used for the 16th NASA Extreme Environment Mission Operations analog will be used to further evaluate spacewalking exploration strategies. For each mode, a circuit of various types of simulated asteroid material – made of gravel, rubber chips, cork and large rocks – has been set up for crew members to conduct science and engineering operations, as they would on an asteroid surface.

When ARGOS is used as part of the larger mission, one crew member will conduct a simulated spacewalk from inside the VR Lab, while the other is harnessed into ARGOS. The ARGOS crew member will move across the simulated asteroid surface along a translation line strung between two anchors. The crew member in the VR Lab will simulate free flying via jetpack. The spacewalkers will divide a series of tasks between themselves and evaluate which method is most effective for each task.

For the stand-alone tests, the crew members will evaluate four modes of moving around an asteroid: translation lines, jetpack, telescoping boom and a combination of boom and translation lines. The crew members will to rate the efficiency and effectiveness of each option.

Fuel Cell

Fuel cells have been a major part of space travel since the Gemini program, and they continue to be the focus of much research and development. By using fuel cells as power sources, vehicles can maintain their orientations based on mission demands rather than sun position, as is the case with solar arrays. Fuel cells are capable of responding to load spikes and dips instantaneously and, when packaged and designed for flight, require limited crew interaction. They can be sized to provide whatever power the mission needs, and they produce pure water as waste product, which can then be used in the vehicle's thermal system for cooling or in the life support system for crew consumption.

The fuel cell being tested during RATS 2012 is a modified version of the 5 kilowatt fuel cell used as a mobile recharge unit for the SEV at RATS 2010. The updated version is capable of providing up to 3 kilowatts at 320 volts to the SEV while producing all the power it needs to run itself. The water created during this demonstration will be transferred via pump to a water cleanup module provided by NASA's Kennedy Space Center in Florida. The water cleanup module then will supply deionized water to an electrolyzer at Johnson. The electrolyzer will split the water into hydrogen and oxygen and refill the fuel cell's reactant storage tanks. This process will attempt to demonstrate a discrete regenerative fuel cell system, which will help support the fuel cell's viability as a long-term power source in space.

The fuel cell is housed in the Portable Utility Pallete, or PUP, which is located directly behind the SEV. The PUP was provided by NASA's Langley Research Center in Hampton, Va.

Crew Roles and Responsibilities

A recurring theme of NASA's analog tests is to identify the most efficient way to distribute crew members across the various elements and tasks of a mission. RATS 2012 will continue to analyze the best use of crew time and resources. Throughout the simulated mission, any of the crew members could be working in the SEV, on a spacewalk or assigned to the simulated Deep Space Habitat (DSH) workstation, a small command and control station that would reside in the larger home base for crews on a mission to an asteroid. Four different, basic crew distributions will be evaluated:

- One in the SEV, one on a spacewalk and two in the DSH
- One in the SEV, two on a spacewalk and one in the DSH
- Two in the SEV, one on a spacewalk and one in the DSH
- Two in the SEV, two on a spacewalk and none in the DSH

Mission Operations Team

A temporary Analog Mission Control Center has been set up at Johnson to support NASA's various analog missions with science and support teams similar to those that support the space station.

For RATS 2012, there will be six positions:

- Flight Director (oversees the mission and acts as the spacewalk officer)
- Capsule Communicator (communicates directly with the crew)
- Operations Planner (coordinates the crew's daily timeline)
- Communications Officer (manages the communication infrastructure and the communications time delay)
- Data Management Officer (manages all data transmissions and infrastructure)
- Science Communicator (coordinates science activities and communicates directly with the crew during simulated science operations)

The Asteroid: Itokawa

RATS 2012 will simulate a mission to the asteroid Itokawa. Itokawa is a stony near-Earth asteroid, approximately 1,771 feet by 984 feet, which makes it roughly 5 times as long as the International Space Station. It was named after Hideo Itokawa, who was known as the father of Japanese rocketry.

The Japan Aerospace Exploration Agency's (JAXA) Hayabusa spacecraft visited Itokawa in 2005. Hayabusa, which means "Falcon" in Japanese, launched from Japan in 2003 to collect samples from the surface of the asteroid. It began its return to Earth in January 2007 and landed in Australia in June 2010 with dust particles. This was the first time samples from an astreroid were collected. Scientists now are studying these samples.

JAXA's Hayabusa mission has provided the best images and information so far on the type of asteroid that astronauts may one day visit. It is unlikely that Itokawa will be the target of any human missions in the near future, but the Hayabusa mission has provided the RATS team with information on how to simulate an NEA environment. The images the crew will see, both from inside the SEV and from their virtual reality helmets, will be based on modified images of Itokawa.

Photo: JAXA

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